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Document Title **LAT Calorimeter CDE Electrical Ground Support Equipment Specification**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT) Calorimeter

CDE Electrical Ground Support Equipment Specification

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

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01	21/6/01	Initial Release
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Table of Contents

1   INTRODUCTION

1.1   PURPOSE

This document defines requirements for the test equipment devoted to CDE final property measurement and acceptation before further integration step, namely the integration into the PEM.

1.2   SCOPE

The CDE EGSE, or test bench, is used for testing Engineering Model CDEs, as well as those for the Qualification Model and Flight Models.

1.3   APPLICABLE DOCUMENTS

Documents and drawings that are relevant to the development of the PEM EGSE and its requirements include the following:

NASA-STD-8739.7	Electrostatic Discharge Control
LAT-SS-00115	LAT Mechanical Systems – Level III Specification
LAT-MD-00408	LAT Program Instrument Performance Verification Plan
LAT-SS-00210	LAT-CAL Subsystem Level IV Specification
LAT-SS-00222	Calorimeter Module Assembly, Test, and Calibration Requirements
LAT-SS-00262	Calorimeter Module Assembly and Test Plan
LAT-DS-00239	CAL EM CsI Crystal Detector Element Specification
LAT-DS-01133	CAL CsI Crystal Detector Element Specification
LAT-SS-01xxx	Calorimeter Functional Test Procedure

1.4   DEFINITIONS AND ACRONYMS

1.4.1   Acronyms

AFEE	Analog Front End Electronics of the Calorimeter
CAL	Calorimeter Subsystem of the LAT
CDE	Crystal Detector Element of the PEM
DAS	Data Acquisition System
ESD	Electrostatic Discharge
GLAST	Gamma-Ray Large Area Space Telescope
LAT	Large Area Telescope
PEM	Pre-Electronics Module
TBD	To Be Determined
TBR	To Be Resolved

1.4.2   Definitions

cm	centimeter
Dead time	Time during which the instrument does not sense and/or record gamma ray events during normal operations
eV	Electron Volt
MeV	Million Electron Volts, 10^6 eV

mm   millimeter
nm   nanometer
ph   photons

2   INTRODUCTION

The purpose of the CDE test bench is to check the overall detection properties of the individual CDEs, six by six, before their integration into the PEM.

2.1   CRYSTAL DETECTOR ELEMENTS

The Crystal Detector Element (CDE) is the article to be tested. Each CDE is made of one CsI crystal with two dual PIN photodiodes bonded to its two end faces and wrapped with VM2000 reflective strips [reference the CAL CDE Specification, LAT-SS-01133]

2.1.1   Handling and Transportation Requirements

LAT-PS-00809 details the CsI Crystal and CDE Handling Procedure.

2.2   TEST BENCH GENERAL DESCRIPTION

The CDE test bench uses collimated gamma-rays from a radioactive source, as well as a UV laser beam to test the CDE properties. The UV laser beam is only used for monitoring the small PIN signal during the set-up of the bench, relative to that of the big PIN obtained by a 22Na 1.275 MeV line. With a 228 TH (or AmBe) radioactive source a 2.6 MeV (or 4.43 MeV) signal will be used to test both small and big PINs.

The test bench consists of:

- 1 X,Y programmable table devoted to positioning of the radioactive source along the CDE top faces (accuracy of 0.1 mm both horizontal and vertical , distance to crystal top face 1mm (TBR)).

- 1 ^{22}Na (^{228}TH or AmBe asap) with an activity level of few micro-Curie.

- 1 Laser beam at 266 nm (to be used only with ^{22}Na), repetition rate ~few kHz, average power ~2mW and an UV light splitter for six channels.

- Structure that holds 6 CDEs at well defined positions (accuracy of 0.1 mm) and ensures hermetic closure to light as well as EMI-EMC shielding.

- Electronics connected to the CDE for read out. The signals are shaped and then digitized.

- 1 PC-VME based acquisition system. Online analysis capabilities should allow to check the data-taking.

2.3   LIFE PHASES

This test bench shall verify the performance of the following CDEs:

- Engineering models (EM) at Collège de France

A second generation bench, devoted to industrial use by the CDE subcontractor will be manufactured for testing the CDEs for the two Qualification Models (QM), and 16 Flight Models (FM).

1   REQUIREMENTS TO BE VERIFIED

The EGSE must be able to verify the following CDE requirements.

1.1   CDE LIGHT YIELD PERFORMANCES REQUIREMENTS

[Derived from LAT SS-00018-D3,5.3, 5.4)]

The test bench shall be capable of measurement of the yield output for each crystal with a 5% (TBR) absolute accuracy and 3 %(TBR) relative accuracy for both the small and large diode.

1.2   CDE LONGITUDINAL LIGHT ATTENUATION PERFORMANCE REQUIREMENTS

[Derived from LAT SS-00018-D3,5.6.5)]

16 (TBR) measurement points will be made on the longitudinal face of each CDE in order to check its light attenuation properties, according to the crystal specifications.

2   TECHNICAL REQUIREMENTS FOR THE EGSE

2.1   X,Y TABLE

The X,Y table should cover a useful area of 400x300 mm, allowing the disposal of 6 CDEs with an step of 25 mm. CDEs are laid on their larger face (27.9 mm).

The positioning accuracy should be 0.1 mm both on the horizontal and vertical dimensions.

The positioning of the radioactive source should be at a distance of 1mm over the top of the longitudinal face of the CDE, with 0.1mm accuracy.

16 points, spaced by 2cm from each other, should be programmed for placing the radioactive source along the CDE top face.

2.2   RADIOACTIVE SOURCE

A collimated 22Na (228TH or AmBe asap) with an activity level of few micro-Curie is required.

The source should be collimated in a Lead well of 8 cm deep, with an opening radius of 5mm, and a surrounding Lead thickness of at list 5 mm. The weight of the collimation system should not exceed 500 g.

2.3   LASER BEAM

The Laser system should deliver a stable beam at 266 nm, with a repetition rate of 5-20 kHz, and an average power of 2mW. The beam divergence should be less than 3 mrad (full angle). The laser beam should be delivered on the end face of each CDE, on the naked margin of the CsI, around the PIN diode.

Remark : tests have shown the irrelevance of the impact position and angle of the laser beam regarding the produced excitation within the CSI.

2.4   DAQ AND ELECTRONICS

2.3.1   *Analog Front End Electronics*

Signals are amplified, shaped and amplified in a hybrid Preamplifier manufactured by EV-products (ev 5093) with a gain of 3.6 mV/fC and a noise level of less than 300 electrons for 10 pF.

The signals are then shaped and amplified by a spectroscopic type amplifier with :

- for the big PIN : 2 shaping outputs adjusted to 6 (TBR) microsecond and 0.5 (TBR) microsecond

- for the small PIN: one output adjusted to 6 (TBR) microsecond

2.4.1.1   PIN diode acquisition channel performances

The overall RMS electronic noise of the AFEE should be less than 2000 (TBR) electrons and 500 (TBR) electrons for the large and small area PINs, respectively.

PIN diode acquisition energy range: The test bench shall process energy depositions on each PIN diode in the energy range from 0.1 MeV to 50 MeV (TBR). This energy range corresponds to the spectral energy repartition of the envisaged radioactive source and the laser beam incident on naked CsI.

2.3.2   *Trigger*

The 12 (for six crystals) fast channel shaper outputs are used to form the trigger in the following way :

- The 12 signals are input to a fast discriminator.

- The left and right discriminated signals of each CDE are input to a logical OR unit (TBC) to produce the trigger signal.

To save channels on the logical module, the 4 signals of 2 crystals are input to the same sub-module; these should not come from side-by-side crystals, but from e.g. Crystal 1 and 3, 2 and 4, 3 and 6 to minimize the chance probability of random triggers.

2.3.3   ADC

24 channels of 12 bit peak-sensing ADC, with a 4V full range dynamics will be used to digitize the signals.

2.3.4   Critical points

The critical point is the noise level of the small area PIN readout channel.

2.5   EGSE IMPLEMENTATION

2.3.5   Material list

Item	Number of units
X,Y Table PC drived	1
16 channel Prog Spectroscopy Amplifier N568B(CAEN)	2
32 channel Peak sensing ADC V785AB(CAEN)	1
16 channel V814 (CAEN)	2
Logical unit NIM N405 (CAEN)	1
Dual Timer NIM N93B (CAEN)	1
Dual Gate and Generator. V 462 (TBD)	1
EV-5093 charge pre -amp	24
Bias Voltage system (TBD)	1

2.3.6   Physical characteristics

The Cosmic test bench shall enter the lift, and pass through doors.

2.3.7   Electrical requirements

The test bench shall be supplied on the electrical network 220V/50Hz.

2.3.8   EMI/EMC and grounding

The CDE test bench shall be grounded properly, and shielded from external electromagnetic waves.

2.6   OPERATIONAL REQUIREMENTS

2.6.1   Operating modes

2.6.1.1   Triggering

- CDE self trigger (radioactive source signal)

- Laser trigger

- Random trigger (dual timer).

2.6.1.2   Absolute calibration

The test bench electronic channels shall be calibrated using a calibrated charge injector or the 60 keV line from 241 Am (absolute calibration).

2.6.1.3   Charge injection

The linearity of the electronics must be determined by charge injection using a pulse generator.

2.6.2   Duration of testing

The CDE testing of 6 units shall be completed within 3 hours (TBR) .

Data analysis shall take less than one hour (TBR).

2.6.3   Data acquisition and storage

2.6.3.1   Data acquisition

The following row data are recorded event by event:

- diode signals,

- diode identification,

- X,Y table informations,

- temperature of the Front End Electronics,

- event number,

- time of event.

2.6.3.2   Data file name

TBD

2.6.3.3   Data associated information

Each file must contains the following information:

- purpose of the run : calibration, test, CDE test

- CDE identification,

- triggering mode,

- time and date of start of the test,

- time and date of end of the test,

- name of the operator.

2.7   SOFTWARE REQUIREMENTS

2.7.1   On line Analysis

The On Line Analysis shall be able to demonstrate that test bench is working properly.

Failures in each CDE channel shall be easily detected, TBD

2.7.2 Results of data analysis

The results must display the following information:

TBD

2.8 INTERFACE REQUIREMENTS

Each of the CDE shall be connected to test bench Front Electronic though the PIN diode flex in ZIF connectors.

2.9 ENVIRONMENT CONSTRAINTS

2.9.1 Humidity

The humidity of the test room does not exceed 40 %.

2.9.2 Temperature

The temperature of the room is fixed at 25+/- 2 °C.

2.9.3 Cleanness

The CDE environment is free of dust at the level defined by ISO 7 norm.

2.9.4 Darkness

The inside of the box containing the CDEs is dark

2.10 LOGISTIC CONSTRAINTS

2.10.1 Packaging

A chariot and a container shall be foreseen in order to transport the CDE EGSE easily.

2.10.2 Transportation and handling

During its different life phases, the test bench will be transported on different sites. Test bench dimensions shall be compatible with the available space in these sites: in particular, dimensions of doors (TBD) shall be taken into account.

The test bench could be dismountable in sub-assemblies in order to meet this requirement.

2.10.3 Storage

TBD

2.10.4 Identification and marking

TBD